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United States Patent [19]

Ling et al.

[11] **Patent Number:** **5,619,524**[45] **Date of Patent:** **Apr. 8, 1997**[54] **METHOD AND APPARATUS FOR COHERENT COMMUNICATION RECEPTION IN A SPREAD-SPECTRUM COMMUNICATION SYSTEM**[75] Inventors: **Fuyun Ling**, Hoffman Estates; **Thomas A. Sexton**, Schaumburg; **Gene Bruckert**, Arlington Heights, all of Ill.[73] Assignee: **Motorola, Inc.**, Schaumburg, Ill.[21] Appl. No.: **396,453**[22] Filed: **Feb. 28, 1995****Related U.S. Application Data**

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[51] **Int. Cl.⁶** **H04K 1/00; H04B 1/66**[52] **U.S. Cl.** **375/200; 375/377**[58] **Field of Search** 375/208, 206, 375/200, 340, 343, 362, 365, 366, 377, 225, 334, 355, 205; 370/84, 105.1, 105.4, 106, 18, 19, 22, 100.1, 101; 327/164[56] **References Cited****U.S. PATENT DOCUMENTS**

5,103,459	4/1992	Gilhousen et al.	375/208
5,309,474	5/1994	Gilhousen et al.	375/208
5,329,547	7/1994	Ling	375/206
5,361,276	11/1994	Subramanian	375/208
5,396,516	3/1995	Padorani et al.	375/225
5,412,686	5/1995	Ling	375/200
5,428,647	6/1995	Rasku et al.	375/366

OTHER PUBLICATIONS

G. Irvine and P. McLane, "Symbol-Aided Plus Decision-Directed Reception for PSK/TCM Modulation on Shadowed Mobile Satellite Fading Channels," IEEE Journal on Sel. Areas. in Com, vol. 10, No. 8, Oct. 1992, pp. 1289-1299.

A. Kajiwar, "On Synchronous CDMA for Mobile Communications," (Globecom '92?), pp. 858-862.

C. D'Amours, M. Moher, A. Yongacoglu, J. Wang, "RAKE Receiver Structures for Differential and Pilot Symbol-Assisted Detection of DS-SS-CDMA Signals in Frequency-Selective Rayleigh Fading Channels," Globecom '93, pp. 1798-1802.

F. Ling, "Coherent Detection with Reference-Symbol Based Channel Estimation for Direct Sequence CDMA Uplink Communications," VTC '93, pp. 400-403.

R. Pedovani, "Reverse Link Performance of IS-95 Based Cellular Systems," IEEE Communications, 3Q94.

G. Brismark, M. Ewerbring, T. Sandin and P. Teder, "A Coherent Detection Scheme for the Uplink Channel in a CDMA System," VTC '94, pp. 729-732.

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[57] **ABSTRACT**

A method and apparatus is provided for facilitating coherent communication reception. A received reference symbol coded spread spectrum communication signal is despread with a spreading code to derive a stream of reference samples and a stream of data samples. The channel response is estimated by utilizing the stream of reference samples. An offset frequency detector determines an offset to be applied to the received signal via a frequency locked loop, while a timing control compensates for slow timing drift and fast fading based on power estimates derived from the stream of reference samples and/or the stream of data samples. A rate estimator determines the rate at which the information was encoded, and the rate information is used to optimize the timing control, frequency offset detector and channel estimator. Thus an improved detection of estimated data symbols from the stream of received data samples is provided.

17 Claims, 10 Drawing Sheets